PCT/FI2003/000964
07-12-2004
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nology have generally been implemented on a laboratory scale only, whereas the present invention is implemented on an industrial scale.

It has been observed that, in water wash, the woollen textiles, which were treated with the present invention, shrank 3% or less from the original. It was further observed that the textiles retained their properties for at least five or as many as 20 successive washings.

The finish according to the present invention can be carried out on dyed or undyed woollen textiles. According to a preferred embodiment of the invention, the woollen textile is first subjected to enzyme treatment and then to dyeing. It has been observed that extremely good dyeing results are obtained in this way. The colours have been found to be brighter and deeper, when dyeing is carried out after the enzyme treatment.

Woollen textiles are mainly made by using the combed or the worsted wool yarns methods. In the combed method, long-stapled wool is used, from which lightweight or medium-heavy woven and knitted fabrics are made. Examples of combed articles include suiting, trousering and light knitted fabrics. Woollen textiles can be dyed as tops, yarn, fabric or ready-made articles.

For the worsted wool yarns, short-staple wool is used, from which heavy weight woven and knitted fabrics are made. Examples of products made by using the worsted wool yarns include upholstery fabrics, thick knitted fabrics, felts, flannels and tweeds. These woollen textiles are dyed as fibre, yarn, fabric or finished articles.

"The finish of woollen textiles" refers to any procedure that can be used to remove the rough feeling of the woollen textile and to make the surface of the wool look smooth, not pilling. The woollen textiles can be finished by means of either wet or dry finishing. In yarn dyed fabrics, mere steaming may be enough; generally, however, the woollen textiles are washed and stentered (wet fixing) after weaving. In this connection, the finish of woollen textiles refers to wet finishing, which can also include dyeing treatment.

The term "woollen textile" in connection with this invention refers to wool fibre or wool fibre-containing tops, yarn, knitted or woven fabric containing at least 30%, preferably at least 50%, most preferably at least 70% of wool fibre. The wool fibre refers to fibre containing 100% wool. The wool tops or bay-yarn, in turn, can be pure wool, or the wool fibre may have been woven into or mixed with a synthetic fibre, such as polyacryl or polyester. The wool fibre may also have been woven into or mixed with some other protein-containing fibre, such as silk, or with some other

PCT/FI03/00964
07-12-2004

Biotechnical finishing method for wool

Tests: 1 to 21

Material: 100% woollen cloth, worsted yarn
1x1 plain weave, 190 g/m2,
off-white

Conditions of the protease treatment: **TABLE 4**

1) Trial sample size	1716 g
2) Liquor ratio	1:30
3) Temperature	50°C
4) pH	9
5) Time	30 min
6) Mechanics	2

Appearance and touch

No of sample	Appearance and touch
1	0
2	0
3	0
4	+
5	+
6	+++++
7	++++
8	+
9	+
10	++
11	++
12	+
13	+
14	++
15	++
16	+
17	+
18	++
19	++
20	+
21	0

Biotechnical finishing method for wool

TABLE 5

Test numbers: 30 to 39

Material: E, 100% wool, worsted wool yarn, plain knitted fabric, colour 1 lilac, 375 g/m2

Conditions of the protease treatment:

1) Trial sample size:	600 g
2) Liquor ratio;	1:30
3) Temperature:	50°C
Temperature in tumble-drying:	50°C
Residual moisture after tumble-drying	10 to 30%

1st Dimensional change
3= dimensional change in the direction of the warp in protease treatments (%)
4= dimensional change in the direction of the weft in protease treatments (%)

2nd Dimensional change
5= dimensional change in the direction of the warp in water washes (%)
6= dimensional change in the direction of the weft in water washes (%)

Dimensional change

					3	4	5	6
No of sample	Dose ml/g	pH	Min.	Mech.	Warp	Weft	Warp	weft
30	-	-	-	-	-	-	5.1	-4.2
32	0.0125	7	30	0	3.3	-3.0	1.0	-1.0
33	0.25	9.5	15	0	5.5	1.0	-1.0	0.2
34	0.125	9.5	15	0	4.0	-2.0	0.9	0.1
35*)	0.025	9.5	30	2	11.7	0.7	-4.5	0.7
36	0.0125	7	30	1	9.3	-3.1	-0.2	0.7
37*)	0.0125	7	30	2	17.8	6.2	-4.6	0.4
38	0.0125	9.5	30	1	8.4	-2.2	-0.2	-0.3
39*)	0.0125	9.5	30	2	16.6	3.1	-4.2	-0.4

*) Felted in protease treatments

AMENDED SHEET

PCT/FI 0 3 / 0 0 9 6 4
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TABLE 6

Biotechnical finishing method for wool

Test numbers: 30 to 38

Material: E, 100% wool, worsted wool yarn, plain knitted fabric, colour 1 lilac, 375 g/m2

Conditions of the protease treatment:

1) Trial sample size:	600 g
2) Liquor ratio;	1:30
3) Temperature:	50°C
Temperature in tumble-drying:	50°C
Residual moisture after tumble-drying	10 to 30%

Abrasion resistance and pilling

					7			8	9
No of sample	Dose ml/g	pH	Min.	Mech.	Pilling			Abrasion resistance, rotations	Abrasion resistance, % of the original
					125	500	2000		
30	-	-	-	-	**3.0**	**2.0**	**1.5**	**56 000**	0.0
32	0.0125	7	30	0	4.5	3.0	3.0	49 000	11.6
33	0.25	9.9	15	0	4.0	3.0	2.0	42 500	24.1
34	0.125	9.5	15	0	3.5	3.0	2.0	47 000	16.1
36	0.0125	7	30	1	4.5	3.5	3.0	48 100	14.1
38	0.0125	9.5	30	1	4.3	3.6	3.1	48 000	14.3

PCT/FI 03/00964
07-12-2004

TABLE 7

Biotechnical finishing method for wool

Test numbers: 30 to 39

Material: E, 100% wool, worsted wool yarn, plain knitted fabric, colour 1 lilac, 375 g/m2

Conditions of the protease treatment:

1) Trial sample size:	600 g
2) Liquor ratio;	1:30
3) Temperature:	50ºC
Temperature in tumble-drying:	50ºC
Residual moisture after tumble-drying	10 to 30%

Appearance and touch

No of sample	Appearance and touch
30	-
32	+++++
33	+
34	+
35	---
36	++
37	---
38	+++
39	---

Biotechnical finishing method for wool

TABLE 8

Test numbers: 40 to 52, 58 to 61

Material: G, 100% wool, worsted wool yarn, plain knitted fabric, colour 2 petroleum, 375 g/m2

Conditions of the protease treatment:

1) Trial sample size:	600 g
2) Liquor ratio;	1:30
3) Temperature:	50°C
Temperature in tumble-drying:	50°C
Residual moisture after tumble-drying	10 to 30%

1st Dimensional change
3= dimensional change in the direction of the warp in protease treatments (%)
4= dimensional change in the direction of the weft in protease treatments (%)

2nd Dimensional change
5= dimensional change in the direction of the warp in water washes (%)
6= dimensional change in the direction of the weft in water washes (%)

Dimensional change

					3	4	5	6
No of sample	Dose ml/g	pH	Min.	Mech.	Warp	Weft	Warp	Weft
40	0.0125	7	15	0	-2.1	1.7	-2.1	1.2
41	0.0125	7	15	1	6.8	-1.6	-0.8	0.9
42	0.125	7	15	0	5.4	1.5	-1.0	-0.6
43	0.125	7	15	1	6.3	0.5	2.9	-1.6
44	0	7	15	0	4.9	2.5	3.8	0.0
45	0	7	15	1	7.0	-2.2	3.6	0.6
46	0	7	30	0	4.6	2.0	3.0	-3.6
47	0.0125	7	30	1	7.9	-0.2	2.2	-0.1
48	0.125	7	30	0	2.8	0.2	-0.2	0.3
49	0.125	7	30	1	8.3	1.5	1.6	-1.1
50	0.0125	7	30	0	3.9	2.9	1.2	-0.2
51	0	7	30	1	7.1	2.2	3.2	-3.0
52	-	-	-	-	-	-	**4.1**	**3.1**
58	0.0125	9.5	30	0	-0.8	5.3	0.0	1.1
59	0.0125	9.5	30	1	1.3	6.8	1.3	2.1
60	0.125	9.5	30	0	3.7	-0.9	-1.0	2.5
61	0.125	9.5	30	1	4.2	1.8	1.7	-0.1

Biotechnical finishing method for wool

TABLE 9

Test numbers: 40 to 52, 58 to 61

Material: G, 100% wool, worsted wool yarn, plain knitted fabric, colour 2 petroleum, 375 g/m2

Conditions of the protease treatment:

1) Trial sample size: 600 g
2) Liquor ratio; 1:30
3) Temperature: 50°C
Temperature in tumble-drying: 50°C
Residual moisture after tumble-drying 10 to 30%

Abrasion resistance and pilling

					7			8	9
No of sample	Dose ml/g	pH	Min.	Mech.	Pilling			Abrasion resistance, rotations	Abrasion resistance, % of the original
					125	500	2000		
40	0.0125	7	15	0	**4.0**	**3.0**	**2.0**	**52 900**	5.5
41	0.0125	7	15	1	4.5	3.5	3.0	50 900	9.1
42	0.125	7	15	0	5.0	4.0	3.5	48 150	14.0
43	0.125	7	15	1	4.5	3.0	3.0	46 000	17.9
44	0	7	15	0	4.0	3.0	2.5	51 600	7.9
45	0	7	15	1	4.5	3.5	2.5	52 050	7.1
46	0	7	30	0	4.0	2.5	2.0	52 150	6.9
47	0.0125	7	30	1	4.5	3.5	3.0	48 900	12.7
48	0.125	7	30	0	4.5	3.5	3.0	48 100	14.1
49	0.125	7	30	1	4.0	3.0	3.0	44 050	21.3
50	0.0125	7	30	0	4.0	3.0	3.0	51 500	8.0
51	0	7	30	1	3.0	2.0	1.5	55 500	0.9
52	-	-	-	-	**3.0**	**2.0**	**1.0**	**56 000**	**0.0**
58	0.0125	9.5	30	0	4.5	3.5	3.0	50 000	10.7
59	0.0125	9.5	30	1	4.5	3.5	3.0	49 000	12.5
60	0.125	9.5	30	0	4.0	3.0	2.5	47 000	16.1
61	0.125	9.5	30	1	4.0	3.5	2.5	44 800	20.0

Biotechnical finishing method for wool

TABLE 10

Test numbers: 40 to 52, 58 to 61

Material: G, 100% wool, worsted wool yarn, plain knitted fabric, colour 2 petroleum, 375 g/m2

Conditions of the protease treatment:

1) Trial sample size:
2) Liquor ratio:
3) Temperature:
Temperature in tumble-drying:
Residual moisture after tumble-drying

Appearance and touch

No of sample	Appearance and touch
40	+
41	+
42	++
43	+
44	-
45	-
46	-
47	+++
48	++
49	+
50	++++
51	-
52	-
58	+++++
59	+++
60	++
61	+

Biotechnical finishing method for wool

TABLE 11

Test numbers: 62 to 70, 77 to 81

Material: H, 100% knitted woollen fabric, worsted wool yarn, 1x1 ribbing, 430 g/m2

Conditions of the protease treatment:

1) Trial sample size:	600 g
2) Liquor ratio;	1:30
3) Temperature:	50°C
Temperature in tumble-drying:	50°C
Residual moisture after tumble-drying	10 to 30%

1st Dimensional change
3= dimensional change in the direction of the warp in protease treatments (%)
4= dimensional change in the direction of the weft in protease treatments (%)

2nd Dimensional change
5= dimensional change in the direction of the warp in water washes (%)
6= dimensional change in the direction of the weft in water washes (%)

Dimensional change

						3	4	5	6
No of sample	Dose ml/g	pH	Min.	Enzyme mech.	Dyeing mech.	Warp	Weft	Warp	Weft
62	0	7	15	0	0	0.9	4.0	3.7	-2.9
63	0	7	15	1	1	4.7	4.0	3.8	4.2
64	0.0125	9.5	30	1	1	3.8	6.6	1.0	-0.2
65	0.0125	9.5	30	1	1	6	5.7	0.1	-0.7
66	0	9.5	30	1	1	7.8	6.0	4.5	-3.6
67	0.0125	9.5	30	1	1	6.3	5.3	0.0	-0.3
68	0.0125	9.5	30	1	1	6.6	6.0	1.1	-0.9
69	0.0125	9.5	30	1	1	7.2	4.7	1.4	-0.3
70	0.0125	9.5	30	1	1	6.3	6.5	1.6	-0.7
77	0.0125	9.5	30	1	1	6.5	3.4	1.3	-1.0
78	0.0125	9.5	30	0	1	4.2	4.8	1.7	-0.4
79	0.125	9.5	30	0	1	4.2	3.1	0.9	-0.6
90	0.25	9.5	30	0	1	2.9	4.5	0.6	0.0
81	0.0125	9.5	30	1	1	4.4	3.9	1.3	0.5

AMENDED SHEET

PCT/FI03/00964
07-12-2004

CLAIMS:

1. An industrial process for treating woollen textiles, **characterized** in that it comprises the following steps:

- bringing a knitted or woven woollen textile in an aqueous solution into contact with a protease enzyme in a large amount of water so as to move the woollen textile as little as possible by adjusting the mechanics to 4 to 10 rpm at a temperature of about 60°C or less for 10 to 90 min,
- inactivating the enzyme by not raising the temperature to over about 60°C or reducing the pH to between 4 and 5,
- making the woollen textile dry in mechanical drying at a temperature of about 60°C or less to a residual moisture content of 10 to 45%, and
- carrying out final drying without mechanics.

2. An industrial process for treating woollen textiles, **characterized** in that it comprises the following steps:

- bringing a knitted or woven woollen textile in an aqueous solution into contact with a protease enzyme in a large amount of water so as to move the woollen textile as little as possible by adjusting the mechanics to 4 to 10 rpm at a temperature of about 60°C or less for 10 to 90 min,
- taking the woollen textile to dyeing conditions and dyeing the textile,
- making the woollen textile dry in mechanical drying at a temperature of about 60°C or less to a residual moisture content of 10 to 45%, and
- carrying out final drying without mechanics.

3. The method according to claim 1 or 2, **characterized** in that the protease treatment is carried out under neutral or alkaline conditions, preferably at a pH of between 6 and 11.

4. The method according to any of the preceding claims, **characterized** in that the protease is serine protease.

5. The method according to any of the preceding claims, **characterized** in that, during the protease treatment, the mechanics is adjusted to 4 to 6 rpm.